

130M-1

CONCRETE AND MASONRY

AG 130-M

UNIT OBJECTIVE

After completion of this unit, students will be able to identify and list the ingredients and characteristics of concrete and calculate the amounts and costs of materials required for a particular application. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. List the ingredients and characteristics of concrete.
2. Calculate the amounts and costs of materials required for a particular application.
3. Build proper forms.
4. Mix, pour, reinforce, finish, and cure concrete.
5. Demonstrate the use of the basic tools needed to pour and finish a concrete slab.
6. Describe and use basic masonry techniques and tools.

CONCRETE PROPORTIONS

A. Mixture of Ingredients - Since part of the mixture can greatly affect the strength and durability of the concrete after it hardens, using the correct proportion of each part is critical.

1. Cement Paste

a. This is the mixture of cement and water that determines the concrete's strength; it varies according to water-cement ratio.

1) Water-Cement Ratio

- a) These are usually 5, 6, or 7 gallons of water to 1 sack of cement; the most common ratio is 6:1.
- b) This amount of water takes into account the water in the sand.

2) Cement comes in 94 pound sacks containing 1 cubic foot.

3) Sand has some water attached to its particles. This moisture needs to be estimated and an allowance made for it. The more moisture there is in the sand the less water needs to be added when mixing.

- a) Damp sand falls apart when squeezed into a ball. It contains about 1/4 gallon of water per cubic foot.
- b) Wet sand forms a ball when squeezed but leaves no noticeable moisture on the palm. This is the most usual kind and contains about 1/2 gallon of water per cubic foot.
- c) Very wet sand forms a ball when squeezed and leaves moisture on the palm. It contains about 3/4 gallon of water per cubic foot.

Note: To obtain a more durable concrete to withstand severe weather conditions and/or traffic, add less water.

2. Ratio of Cement: Fine Aggregate (Sand):Coarse Aggregate (Gravel)

a. Ratio is expressed as a three digit number called a mix, for example, 1:2:3.

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- 1) A 1:2:3 mix means one part cement, two parts sand, and three parts gravel.
- 2) The mix proportions can be based on either weight or volume.
 - a) A ratio of 1:2:3 can be stated 1 cu. ft. (sack) of cement, 2 cu. ft. of sand, and 3 cu. ft. of gravel.
 - b) It can also be 100 lb. (approximately a sack) of cement, 200 lbs. of sand, and 300 lbs. of gravel (1 cu. ft. of aggregate is approximately 100 lbs.).

b. A correct mixture assures that:

- 1) Each particle of sand and gravel is covered with cement paste.
 - 2) Each particle is bound to others when the cement paste dries and hardens.
- c. The intended use of the concrete also determines the ratio of the ingredients. Recommended ratios for mixing concrete for different types of uses can be found in charts in any basic book about concrete (consult references and resources listed).

3. Coarse Aggregate Size

- a. Should not exceed $\frac{1}{3}$ the slab thickness.
- b. Should not exceed $\frac{1}{5}$ the wall thickness.
- c. Maximum size is 1 $\frac{1}{2}$ inch with the most common being $\frac{3}{4}$ inch.

4. Mixture Yield

- a. Generally, the volume of mixed concrete will be about two-thirds the combined volume of the items used in the mix.
- b. Examples of how much material should be used to make 1 cubic yard of concrete can be found in charts in any basic book about concrete (consult references and resources listed).

5. Slump Test: slump is a rough measurement of concrete's consistency and workability.

- a. Common slumps used for most jobs are 3 - 4 inches. Slump should never exceed 6".

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b. The slump is determined by a test using a conical cylinder and a portion of the concrete batch to pour. The cylinder has a 4" diameter opening at the top and an 8" diameter opening at the bottom, and is 12" high. The test is performed as follows:

- 1) Place moistened cone-shaped container on a flat, level surface.
- 2) Fill the container 1/3 full with sample of concrete.
- 3) Rod this layer 25 times using jabbing strokes with a 5/8" solid steel rod - jabbing strokes as this helps to settle the concrete.
- 4) Add a second layer until the container is 2/3 full.
- 5) Rod this layer an additional 25 times.
- 6) Finally, fill the cone to the top edge and level it.
- 7) Rod a final 25 times. Remove any spilled concrete from around the base of the cone.
- 8) Lift the cone off the rodded batch within five seconds.
- 9) Without a retaining device the concrete will slump or fall from the original 12" height.
- 10) The difference in the original height and the final height is known as the slump.

ACTIVITY:

1. Using Supplemental Handout #1, have students complete an organic matter test and silt/clay test on their sand samples.
2. Determine moisture content of sand samples. Test different samples of different moisture ranges.
3. Using the information found in basic texts about concrete, solve problems on Supplemental Worksheet #1. More problems can be added if time permits. Use page 130M-47 as an overhead or handout on mixture ratios.

Supplemental Handout #1

TESTING A SAND SAMPLE FOR SILT AND CLAY

Procedure:

1. Fill a one-quart glass jar to a depth of 2 inches with the sand sample to be tested.
2. Add water until the jar is 3/4 full.
3. Screw on the lid and shake vigorously for one minute to mix all particles with water.
4. Shake the jar sideways several times to level the sand.
5. Place the jar where it will not be disturbed for 1 hour for a silt test or 12 hours for a clay and silt test.
6. After 1 hour, measure the thickness of the silt layer on top of the sand.
7. If the layer is more than 1/8 inch thick (more than 3% silt), the sand is not suitable for concrete unless the silt is removed by washing.
8. If the layer is not 1/8 inch thick in 1 hour, let the mixture stand for 12 hours. Then re-measure the layer(s) that have settled on the sand.
9. If the silt plus clay layer exceeds 1/8 inch, wash the sand before using it in concrete.

TESTING A SAND SAMPLE FOR ORGANIC MATTER

Procedure:

1. Place half a pint of clear drinking water in a clear glass quart-size jar.
2. Dissolve a heaping teaspoonful of regular household lye in the water.
3. Add half a pint of the sand sample to the solution.
4. Place a leak proof lid over the jar and shake it vigorously for a minute or more. (Be careful not to spill any of this solution since it is poisonous and highly injurious to the skin, clothes, and other materials.)
5. Let the sample stand for 24 hours.
6. The color of the liquid indicates whether the sand contains too much organic matter to be used in making concrete.

Clear solution - sand is clean and free of organic matter

Straw color (color of apple-cider vinegar) - presence of organic matter but can still be used to make concrete

Darker colored solution - indicates too much organic matter present to be used in making concrete

Name _____

Date _____

Score _____

Worksheet #1
CALCULATING PROPORTIONS

A concrete driveway is to be poured on a level surface. The slab will be 5 inches thick.

1. Specify the maximum size aggregate that should be used on the 5-inch slab.

_____ inch(es)

2. If one part cement, two parts sand, and three parts of gravel were used, how would it be expressed? Using chart provided on page 130M-47.

_____ : _____ : _____

3. With this ratio, how many sacks per cubic yard should be used?

_____ sks.

4. Using the same ratio, how much sand and gravel are needed to make one cubic yard of concrete?

_____ cu. ft. of sand and _____ cu. ft. of gravel

5. If a total of 10 cubic yards of concrete is needed, how much total cement, sand, and gravel should be mixed?

_____ sks. , _____ cu. ft. of sand, and _____ cu. ft. of gravel

ESTIMATING CONCRETE MATERIALS

- A. Volume Estimation - The ability to estimate accurately is a very important skill, since an inaccurate estimate will cause the job to cost more than necessary and ingredients may be wasted. If insufficient material is ordered, the job must be stopped and then restarted with considerable increase in cost and time.

1. Area Calculation (For more information see Section 130C, Measuring)

- a. Calculate the surface area in square feet that the structure will cover.

- 1) To get square footage of rectangular areas:

$$\text{Area} = \text{Length} \times \text{Width}$$

- 2) To find the area of a circle:

$$\text{Area} = 3.1416 (\pi) \times R^2 \text{ (Radius)}$$

- 3) To find the area of a triangle:

$$\text{Area} = 1/2 \times \text{Base} \times \text{Perpendicular Height}$$

2. Volume Calculation

- a. Multiply the calculated surface area by the thickness in feet of the planned structure:

$$\text{Volume} = \text{Area} \times \text{Thickness (Depth)}$$

- b. When calculating the volume of a long, narrow structure (for example, a building footing):

- 1) First find the cross-sectional area of the structure:

$$\text{Area} = \text{Width} \times \text{Depth}$$

- 2) Then multiply the cross-sectional area by the length of the structure.

- c. The total volume of concrete required is expressed in cubic feet.

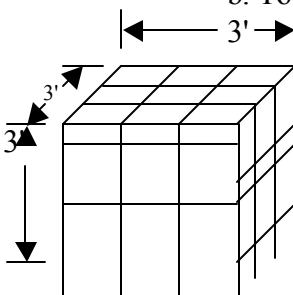
3. Unit Conversion

- a. Concrete is calculated and sold by the cubic yard or the fractional quantities in quarters of a cubic yard.

- b. To convert cubic feet to cubic yards:

$$\text{Volume (cubic yards)} = \text{Volume (cubic feet)} \text{ divided by } 27$$

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4. Dry Bulk Materials

- a. If purchasing separate ingredients, use a chart found in basic texts about concrete (consult references and resources) to calculate the amounts of each item.

- 1) Figure out the cubic yards needed for the project.
- 2) Determine the recommended mixture for the project.
(see page 130M-47)
- 3) Determine the amount of each ingredient by multiplying the value off the chart by the cubic yards needed for the structure. For example, the amount of cement is calculated:

$$\begin{array}{ccccc} \text{Chart Value} & \times & \text{Project Size} & = & \text{Cement Needed} \\ (\text{sacks/cu.yd.}) & & (\text{cu.yd.}) & & (\text{sacks}) \end{array}$$

- b. Cement is bought in whole sacks but separate ingredients can be purchased in increments of a 1/4 cubic yard.

B. Mix Ordering - Once the amount of concrete that is needed for a job has been calculated, a decision must be made about the on a method of mixing it. The deciding factors here are the amount of concrete needed, the time required to complete the job, economy, and convenience.

1. Site Mixed (mix-it-yourself):

- a. This method is for jobs that require less than a cubic yard.
- b. A 10% waste allowance should be added to the calculated amount of concrete needed.
- c. A clean storage area is needed for each ingredient: gravel, sand, and cement (must be kept dry).
- d. This is a very good method when pouring fence posts or small projects such as stepping-stones or walkways.
- e. This is the cheapest way to mix concrete.
- f. There are two methods for site mixing:

1) By Hand

- a) This method is used for very small jobs that require only a few cubic feet.
- b) Mixing is completed on a watertight, flat surface.
- c) Measure accurately and mix cement and sand thoroughly.

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- d) Add and mix gravel.
- e) Add measured quantity of water and mix until every particle has been covered with cement paste.
- f) Additional water might need to be added to obtain correct workability.

2) By Mixer

- a) This method is used when more than a few cubic feet of concrete are needed.
- b) Mixers can be rented from most rental agencies or possibly borrowed.
- c) The mixture is more uniformly and rapidly completed when done in a mixer
- d) Mixers are rated by batch size; do not exceed this amount.
- e) First load the mixer with all the aggregate and half the water; this is pre-measured for the batch size of the mixer.
- f) Start the mixer, add the sand, cement, and the remainder of the water.
- g) Allow the batch to continue mixing for at least three minutes, or until all the materials are thoroughly mixed.

2. Ready-Mix:

- a. This is the best method to use if the job calls for a cubic yard or more, or if time and convenience are important considerations.
- b. Additionally, this method is usually more economical when doing a large job.
- c. A 5% waste allowance should be added to the calculated volume of concrete needed.
- d. Usually the buyer must specify the maximum size of aggregate, minimum cement content, maximum slump, and load bearing capacity.
- e. Three Methods for Ordering Ready-Mix

1) Transit Mix

- a) This is the easiest and cheapest method to use when pouring three yards or more of concrete; less can be ordered but the cost increases.

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- b) The mix is delivered by truck to the exact location.
- c) It is consistent, well-mixed and prepared to specifications before delivery.
- d) The user needs no mixing equipment, no storage.
- e) Since trucks are so big and heavy, planning is needed to insure that the truck can reach the pour site.
- f) There are additional charges if the truck is not poured out in the 45 minute standby time.

2) Porta Mix (U-Cart, Trailer Mix)

- a) This is handled by most concrete batch plants and by some rental companies.
- b) It can be ordered in $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 cubic yard amounts.
- c) It is a very convenient method to pour small jobs around the home.
- d) The user needs no mixing equipment, no storage.
- e) It is consistent, well-mixed concrete; however, no specifications can be made.
- f) It is more expensive than other methods.
- g) The user needs a sturdy truck to pull the trailer.

3) Sack Mix (Sackrete)

- a) This comes in 90-pound sacks containing the right amounts of cement, sand, and gravel.
- b) The user just adds water and mixes; one sack makes around $\frac{2}{3}$ of a cubic foot.
- c) This method is ideal for small jobs, for example, fence posts; the user needs to have a mixer or must hand mix.
- d) It is quite expensive, approximately four times as much as other methods.

ACTIVITY:

1. Locate different concrete structures around the school. Measure the dimensions of the structures and use these measurements to calculate the volume of concrete that was needed to build the structure.
2. Assign each student a company which deals with either transit mix, cart mix, bulk materials, or sack mix to call and find out current prices.
3. Have students complete supplemental worksheet #2. Add some problems of your own.

Name _____

Date _____

Score _____

Supplemental Worksheet #2

Estimating Concrete Quantities

- I. A concrete slab for a steel building is to be poured on a level surface. The dimensions of the slab are: length 40 feet, width 30 feet, and thickness 6 inches. The concrete is to be ordered from a batch (ready-mix) plant. Remember to allow for uneven surface of the dirt base

SHOW ALL WORK!

1. How many cubic feet of concrete are needed? _____
2. How many cubic yards of concrete are needed? _____
3. How much concrete should be ordered from the plant? _____
(Remember to round off answer up to the nearest 1/4 cubic yard.)
4. What is the total cost to complete the job? _____
Make sure to add tax! (Idaho tax is 5%)

II. A concrete walkway is needed along the side of a home. The dimensions of the walk are: width 2 feet, length 20 feet, and thickness 3 inches. The concrete will be site-mixed using a borrowed mixer. The walk will be poured in 4 foot long sections for ease of repair in case of uprooting by the neighbor's tree. Remember to allow for an uneven leveling job done by your assistant.

SHOW ALL WORK!

1. Calculate the total cubic feet of the walkway. _____

2. How many cubic yards does the walkway measure? _____
Remember to take into account the uneven soil surface.

3. The recommended mix is 1 : 2 : 2 1/4 using 3/4 inch maximum aggregate.
 - a. How many sacks (cubic feet) of cement are _____
needed to complete the job? (Round off answer to whole sacks.)

How much would this amount of cement cost? _____
(Remember to include sales tax.)

 - b. How many cubic feet of sand are needed? _____

 - c. How many cubic feet of gravel are needed? _____

Note: Current prices of materials are needed to make this worksheet complete and accurate.

FORM PREPARATION AND REINFORCEMENT

A. SITE PREPARATION

1. Selection of Site
2. Lot lines are located and checked!
 - a. This provides protection for the owner.
 - b. The lines must be completed by a registered engineer or licensed surveyor.
3. Clearing and Rough Excavation of Area
 - a. The site should be cleaned of all debris and refuse.
 - b. Where no grading is needed, the site can be laid out and batter boards erected.
 - c. If the site is on a steep slope or rugged terrain, rough grading must be completed before laying out building lines.
 - d. Topsoil should be removed and stock piled where it will not interfere with the construction. Later it will be used for the finished grade.
4. Laying Out Building Lines
 - a. It is best to establish lines using a leveling instrument.
 - b. Lines can, however, be taken off lot markers.
 - 1) It is important that distances be perpendicular to existing lines and that building lines be square.
 - a) To establish a right angle, use the 3-4-5 method based on the Pythagorean theorem.
 - b) Locate corners formed by the intersection of the outside wall surface.
 - c) Drive stakes into the ground and then set tacks in the tops at the exact spot for the corner.
 - c. After lines have been set up, check them carefully.
 - 1) Measure the lengths and widths.
 - 2) Measure the diagonals which should be equal.
 - 3) An out-of-square foundation can cause continuous problems and frustrations throughout construction.

5. Batter Boards

- a. They are set up around the building layout stakes.
- b. Their purpose is to preserve the building lines after layout stakes have been removed because of necessary excavation for footings and foundations.
- c. Locate them about 4 feet beyond the building lines where excavation work will not disturb them.
- d. To Make Batter Boards:

- 1) Use 2 x 4's for the stakes and 1 X 6's for the ledger boards.
- 2) Drive in stakes to desired depth.
- 3) Nail ledger boards to the stakes, making sure they are level and at a good working height slightly above the top of the foundation.
- 4) All the batter boards should be level with each other.
- 5) Ledger boards should be long enough to extend past each corner.

- e. To Establish New String Lines:

- 1) Pull the two strings so they pass directly over the layout stakes, then use a plumb bob to line up the strings directly over the tack.
- 2) Mark the top of the ledger boards where the string lines cross and then make a shallow saw kerf at the mark.
- 3) Pull the string lines tight and fasten them to nails driven in the back of the ledger boards.
- 4) Make sure the lines are set in the saw kerf.

6. Final Excavation:

- a. Remove lines from batter boards when completing excavation work.
- b. The highest elevation on the perimeter of the excavation is the control point for establishment of the depth of excavation and the height of the foundation.
 - 1) Foundations should extend about 8 inches above the finished grade so the wood finish and framing members will be protected from soil moisture.
 - 2) The finished grade should be sloped so surface water will run away from the foundation.

- 3) It is important that the foundation be located below the frost line so no damage is incurred when the soil freezes.
- c. The depth of the excavation may be limited by the overall levelness of the site, slope to the street, curb or existing concrete foundation height, and the elevation of the drainage or sewer lines.

B. Preparation of Forms

1. Definitions

- a. A form is a metal or wooden structure that confines the concrete to the desired shape or form until it sets or hardens enough to stand by itself.
- b. A footing is a concrete base that provides a solid, level foundation for concrete, brick, or block walls.
 - 1) Because the footer is wider than the wall, it spreads the building weight over a wider area.
 - a) The common practice is to make the footing the same height and twice as wide as the thickness of the wall it supports (on good load-bearing soil), ie., a 4" thick wall would have a footing at least 4" high and 8" wide.
 - b) Footing must be placed below the frost line in order to prevent structural damage.
 - c) The footing should be placed on all rock or all soil and not a part of each; this prevents uneven settling.

2. Form and Footing Construction

- a. Form boards are temporarily nailed to stakes and to each other.
 - 1) Duplex head nails are used to help in form removal.
 - 2) In order to allow nail removal, always nail through the stake into the form board; never nail from the inside.
 - 3) Be sure the stakes do NOT stick up above the top of forms as this will greatly affect the finished work; saw stakes off flush with the form.

- 4) Coat form boards with form oil or diesel fuel since this prevents sticking to the concrete and allows easy removal.

b. Footing Forms:

- 1) After excavation is complete, replace lines on batter boards and locate corners again with plumb bob. Drive stakes to mark points, making sure they are level with top of footing.
- 2) Drive a set of grade stakes along the footing line; use a builder's level to keep all the stakes level with the top of the footing.
- 3) Construct outside forms first, making their tops level with the grade stakes.
 - a) After the outside boards are in place it is relatively easy to set the inside sections.
 - b) Use 3/4 inch plywood or 1 inch lumber for form boards, held in place with metal or 2 X 4 wood stakes every 2 to 3 feet.
- 4) Use spreader boards to maintain the correct width for the footing; usually 1 X 2's are satisfactory.
- 5) The top of the footing must be level!

c. Wall Forms:

- 1) Use 3/4 inch tongue and groove lumber or plywood for side forms nailed to 2 X 4 studs every 2 feet.
- 2) Forms must be strong and well braced to withstand the side pressure created by the heavy, wet concrete.
 - a) This pressure increases as the height of the wall is increased.
 - b) Wall ties (tie rods) are used to prevent the sides from spreading outward or warping inward.

These combine the features of old wood spreaders and wire ties. Many different manufactured devices are available.

d. Slab-On-Ground Forms:

- 1) Concrete is laid directly on ground such as a driveway, sidewalk, or slab floor.
 - a) Soil must be firm and compact, disturbed as little as possible.
 - b) On poorly drained soils, lay a 4"-6" subbase of gravel or crushed rock and compact it.
 - c) A vapor barrier is essential under every section of a slab floor.

This prevents the movement of water from ground into the slab and vice-versa.

Common materials used to create a vapor barrier are 4-mil polyethylene film, 55 lb. roll roofing, or asphalt-impregnated kraft paper.

- 2) Forms are constructed out of 2" thick wood material.
 - a) 2 X 4's are used for walks.
 - b) 2 X 6's are used for drives and floors.
 - c) Support the forms by using metal or 2 X 4 wood stakes every 3 feet.
 - d) Use soft, clean, straight lumber.
 - e) 1" thick wood material can be substituted for small pours; however, it needs to be supported every 2 feet.
 - f) A slope should be included for all slab construction in order to carry off surface water. A slope between 1/8 to 1/4 inch per foot is adequate.

C. Concrete Reinforcement

1. What is reinforced concrete?

- a. It is concrete which has either steel reinforcing rods or wire mesh embedded into it when it is poured.

1) Reinforcement bars (rebars) are used in thicker pours such as foundation footings and building columns.

- a) They are made of steel and have a rough surface to prevent slipping when embedded.

- b) Bars are classified by a number system corresponding to the diameter in eighths of an inch, i.e., # 4 rebars are $4/8$ " (which reduces to $1/2$ "). (They are available in diameters from $1/4$ " to 1" and over.)
- c) Rebars are purchased in 20, 40, and 60 ft. lengths.
- d) Bars can be joined by lapping over ends and wiring together or by welding. (The general practice is to lap bars by 24 times the diameter, i.e., $1/2$ " rebars should be lapped $24 \times 1/2 = 12$ inches.)
- e) For most applications, the bars should be placed $1\ 1/2$ " from all surfaces; however, $3/4$ " is allowed at times. (Rods must be kept off the surface of the base material as this will cause rusting.)
- f) Bars are run vertically in walls and horizontally in footings. In thick slabs, they can be placed in a cross-sectional pattern.

2) Concrete slabs are generally reinforced using wire mesh.

- a) The mesh is steel wire welded to form a cross-sectional pattern. (The sizes are 6, 8, and 10 gauge wire.) (Generally a 6-by-6 inch mesh pattern is used.)
- b) Mesh should be rolled out and flattened, then placed inside the forms.
- c) It can be purchased in different widths and then wired together to form longer or wider pieces. (Different pieces should be overlapped by at least one and a half squares and wired securely.)
- d) It should be located from 1 - $1\ 1/2$ inch below the top surface, approximately in the center of the slab. (Mesh MUST be kept off the base material so some support might be needed. This is to prevent the wire rusting inside the concrete.) (As the concrete is being poured, a steel hook is used to pull the mesh up to the desired height. Small concrete blocks can be used to hold the mesh in place during the pour)

2. Why reinforce concrete?

- a. Reinforcement increases the strength of the concrete without adding extra thickness which would add greatly to the cost of the job.
- b. Reinforcement prevents cracking under stress of floors or driveways where heavy equipment and machinery are used.
- c. All concrete columns and structures must be reinforced with steel in order to withstand normal stresses.
- d. On large complicated jobs, consult local construction engineers or concrete contractors regarding the size and amount of steel to use and how it should be placed.

ACTIVITY:

- 1. Go on a short field trip to a construction site (commercial or residential) and can observe how sites are prepared, forms are constructed, and reinforcement is used. Quiz students on what they observed.
- 2. Plan a concrete project at the school and have students complete the necessary steps to prepare the site, construct forms, and include the necessary reinforcement. This activity could be worked on throughout this lesson. Coordinate this activity with the next lesson, Placing, Finishing, and Curing concrete.
- 3. Go out to the athletic fields and practice laying out corner stakes using the 3-4-5 method and the diagonal method. Set up teams of 3-4 students each. (See Section 130-U, Surveying)

PLACING, FINISHING, AND CURING CONCRETE

A Placing (pouring)

1. Pre-pour Guidelines

- a. Place concrete as close to its final position as possible. Get truck or wheelbarrow as close as possible.
- b. Place concrete in the forms as soon as possible, because concrete starts to harden about 15 minutes after it is mixed; in no case wait more than 45 minutes. Ready-mix companies charge a standby time if the truck is not emptied after 45 minutes.
- c. Before pouring, wet down the base material to prevent the water in the concrete from being drawn into the dry base material. Water loss will weaken the concrete.
- d. Check the forms for the last time with a carpenter's level.
- e. Have all tools at hand and a helper or two.

2. Tools and Equipment

- a. A square point shovel is used to move material and to fill in corners and low spots.
- b. A wheelbarrow is used to move material where the truck and chute cannot reach.

3. Pouring and Spreading

- a. Start placing concrete in a corner and work away from it.
- b. Use a shovel to spread concrete. Do not use a garden rake or hoe because they separate the coarse aggregate.
- c. Dump each succeeding load against the previous one; do not dump in separate piles and rake them together.
- d. The level of concrete should be higher than the forms. This will allow for settling, tamping, and screeding.
- e. Concrete should not be dropped from a large height or thrown too far with a shovel.

B. Tamping

1. Process

- a. Tamping is a means of pushing the coarse aggregate down from the surface and bringing the fine aggregate to the top.

- b. Be careful not to tamp too much!
- c. At this time, run a shovel along the inside of the forms; this will help to push back the coarse aggregates from the edges.
- d. Use a hammer to tap along the forms to help vibrate the fine aggregates to the outside surface and fill in the voids.

2. Tools and Equipment

- a. Hand Tamp (Turkey's Foot) - This is a hand-held device made with a rectangular piece of expanded metal which is operated while standing in the wet concrete. The expanded metal is sized to push down the coarse aggregates and allow the fine aggregate to come up.
- b. Roller Tamp (Jitterbug) - This device has two rollers made of expanded metal; as it is rolled across the surface the gravel is pushed down. The roller type is operated from the outside edge of the slab and comes with extension handles to reach across larger distances.

C. Screeding (striking off)

1. Process

- a. Screeding removes the excess concrete and fills in low spots.
- b. Bring the surface of the concrete even with the top edge of the form.
- c. Place a board across the edges of the form, and move it back and forth in a sawing motion. It is slowly advanced along the slab.
- d. Make sure there is a surplus of concrete against the front face of the screed board to fill in low spots.

2. Tools and Equipment

- a. Screed Board (Straight Edge) - a straight 2 X 4 or 2 X 6 plank (NOTE: It is recommended that this be purchased the morning of the pour in order to insure a straight (unwarped) piece of lumber.
- b. Power Screed - a device that strikes off and compacts the concrete which is used for large pours

D. Floating

1. Process

- a. The floating process brings the fine aggregates and cement paste (cream) to the surface which allows for further finishing.
- b. It also embeds the coarse aggregates just below the surface.
- c. Additionally, it aids in leveling ridges and filling voids left by the screed board.
- d. A hand float is used by holding it flat on the surface and swinging it in a sweeping arc; very light pressure is applied.
- e. Bull floats are pushed and pulled across the surface.
- f. Avoid overworking the concrete while it is soft since this may bring excess water to the surface.

2. Tools and Equipment

- a. Concrete Float - made of wood, aluminum, or magnesium. It consists of a flat rectangular base of wood or metal with a handle attached; the edges of the base are chamfered. Hand floats are used mostly for small jobs and outside edges.
- b. Bull Float - consists of a rectangular wooden board (or lightweight aluminum plate) for a base approximately 3-4 feet long. A swivel pole handle is attached to the base. It comes with extension handles to reach across larger slabs and is operated while standing around the edge of the slab. (NOTE: The following finishing procedures should be completed after the water sheen has disappeared from the surface and the concrete has stiffened slightly.

E. Edging

1. Process

- a. Rounds the corners of concrete in the form.
- b. Prevents edges from chipping off.

2. Tools and Equipment

- a. Concrete Edger - The blade is made of flat sheet steel with a 3/8" edge turned down along the long side to form a rounded corner. The ends are turned up slightly. Some are equipped with handle attachments so they can be used on large pours.

F. Jointing

1. Process

- a. By cutting grooves or placing joints in the slab, the location of cracks can be controlled.
 - 1) A planned break permits the concrete to expand and contract without cracking.
 - 2) If cracks do occur with grooves, it will usually happen below the surface under the groove.
- b. Control joints are needed every 4 to 5 feet apart in sidewalks.
- c. Joints are needed 10 to 15 feet apart for floors, drives, or patios.
- d. Cut a joint down the center of 10 foot and longer slabs.
- e. The depth of the grooves should be at least $\frac{1}{5}$ of the thickness of the concrete.

2. Tools and Equipment

- a. Joint Material - The joint can be created using a $\frac{3}{8}$ " softwood board, $\frac{1}{2}$ " asphalt strip, or by pouring sections at different times and using a compound to prevent the sections from sticking together.
- b. Groover - The bottom blade is flat with a raised ridge down the center that is $\frac{1}{2}$ inch wide and comes in different depths. The base is fabricated of cast or sheet steel. Some type of straight edge must be used.
- c. Power Saw with Masonry Blade - used to create grooves in slabs, usually on large jobs. It cannot be done until 18-24 hours after concrete is poured.

G. Finishes

1. What type of surface is needed?

Consideration:

- a. Slab uses
- b. Interior or exterior
- c. Non-slip or smooth
- d. Sealed for sanitary reasons
- e. Water washing
- f. Decorative

2. Popular Surfaces

a. Floating - The surface should be floated a second time after the concrete has been set so the water and fine material will not be worked to the top.

- 1) It is done with a wood or metal float. Wood floats produce a rougher finish than metal floats.
- 2) Floating gives a medium non-slip surface, good for concrete which is constantly exposed to outside weather and meant for general use.
- 3) This floating procedure is usually completed before doing another surface finish such as troweling.

b. Brooming is used if a rougher finish is required than floating.

- 1) It is done after the second floating operation.
- 2) A damp, stiff-bristled (coarse-straw) broom is pulled lightly across the surface of the concrete.
- 3) This gives a rough surface, provides excellent footing and traction; it is especially good for outside areas which become slick from rainy weather or where there is constant use of water such as in a milking barn.
- 4) For a finer texture, steel trowel the surface first and then use a soft-bristled broom.

c. Troweling produces a smooth, hard surface since this action brings the cement paste to the surface.

- 1) It is done immediately after floating when the surface is semi-hard.
- 2) A troweled surface allows for easy cleanup and is ideal for sanitary conditions; however, it is extremely slippery when wet.
- 3) It is completed with a steel hand trowel which is a rectangular piece of sheet metal with a handle attached.
 - a) For the first troweling, hold the trowel flat against the surface, making sweeping arcs back and forth with even pressure.
 - b) For the second troweling tilt the leading edge of the trowel upward. This step should be done when a hand pressed against the surface leaves only a slight impression.

- 4) This process can also be completed with a power troweler which produces a similar surface to the hand trowel and is excellent for large jobs. To operate the power troweler, the concrete must be hard enough to stand on.
- 5) Additional trowelings will make the surface smoother and harder. However, excessive troweling will leave the surface weak and easily damaged by frost and chemicals.

H. Curing

1. Guidelines

- a. To cure properly, the concrete must be protected from drying air, excessive heat, and freezing temperatures for several days after pouring.
 - 1) Preventing the moisture loss during the early stages of hardening (hydration) is extremely important.
 - 2) Hot, dry weather can cause the water to evaporate too rapidly, so the concrete will not set properly.
 - 3) Extreme cold can cause the water to freeze and expand the concrete. (Special air entraining chemicals can be added to concrete for cold pours. The chemicals create small bubbles which allow the concrete to expand and contract without cracking.)
- b. Concrete must be kept moist and warm while it is setting (hardening).
 - 1) Concrete should dry slowly.
 - 2) This will greatly increase the strength and durability and will prevent the failure (cracking, crumbling, or breaking) of the concrete before the end of its expected lifetime.
- c. Curing time varies from 5 days (warm weather) to 7 days (cold weather), with 6 days being a satisfactory average.
 - 1) Concrete kept moist for seven days is about 50% stronger than concrete which is allowed to dry during the same time.

2) If moisture is maintained for one month, the concrete is double the strength of that which is allowed to dry immediately.

d. Form boards should remain in place as long as possible; if feasible, they should remain until the curing is completed.

2. Different Methods of Curing Concrete

- a. Seal the surface by covering it with plastic sheeting or waterproof paper; joints must be sealed and covering must lay flat and be anchored at the edges.
- b. Cover the concrete with burlap, canvas, sawdust, straw, sand, or another type of insulating material. This covering must be kept continuously wet during the curing time.
- c. Keep the concrete constantly moist with a lawn sprinkler or a soaker hose.
- d. Spray the concrete with a plastic-based curing compound that forms a continuous membrane over the surface. It is essential the coverage be complete.

ACTIVITY:

- 1. Bring students to a construction site where concrete is being poured. This could be coordinated with Activity #1 from the last lesson.
- 2. Continuation of Activity #2 from the last lesson: demonstration of placing, finishing, and curing can be completed. If necessary, mixing can also be included (Supplementary Handout #2 was included to help with site mixing, next page).
- 3. Complete a slump test on the concrete to be poured. Follow the guidelines presented earlier in this section, Concrete Proportions.
- 4. Set up small concrete projects (half-pint milk cartons) which can be used to demonstrate the effects of reinforcement, mixing, temperature, and curing on concrete strength. A small testing unit using a hydraulic press or jack can be built so some quality destructive testing can be performed. Remember to keep safety in mind!

Supplemental Handout #2 - Mixing Concrete

A. Which method should you use to mix concrete?

1. Site Mixing (by hand or mixer)

- a. All ingredients need to be present.
- b. To measure ingredients, construct a cubic foot measuring box or obtain a metal bucket that has been marked to show one cubic foot.
- c. Another option is to measure ingredients using shovelfuls; on the average there are 10 shovelfuls per cubic foot. This can vary according to individual and size of shovel. This method is recommended only for individuals who have experience using shovelfuls.

2. Using a Portable Mixer

- a. With mixer stopped, add in all coarse aggregate and half the water. (The mixer's capacity (batch size) is approximately 60% of its total volume.) (Never exceed the batch size of the mixer.)
- b. Start the mixer, and then add sand, cement, and the rest of the water.
- c. Continue to mix for three minutes or until materials are thoroughly mixed and the concrete is a uniform color.
- d. Place batch into wheelbarrow and move to pour site.
- e. Wash out the drum after each batch; scour at the end of the day adding water and several shovelfuls of coarse aggregate while turning; rinse it out and then dry.

3. Mixing by Hand

- a. Measure out ingredients.
- b. Spread sand in a ring on the mixing area, add cement, and mix until there is a uniform color without streaks. Add coarse aggregate and turn the mix over three times.
- c. Form a depression in the middle of the heap, add some pre-measured water, and work it into the center of the mixture. Add more water as needed and mix until the entire pile is damp.
- d. Shovel the dry part of the mix into the depression until the water has been absorbed. Be careful not to let the walls collapse on the ring. Then turn the whole heap over until it is evenly moist.

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- e. Form a new depression if there is a need to add more water. If only a little water remains to be added, sprinkle it on the surface of the heap. Never change the ratio of cement and aggregate.
- f. To test the mix, draw the shovel backward over the heap in a series of jabs; try to leave clear cut ridges. If mix is too dry, they will be indistinct; if too wet, they will level out.
- g. Shovel batch into wheelbarrow and move to pour site.
- h. Clean up by scouring the mixing area and equipment.

LAYING MASONRY UNITS

A. Masonry is anything constructed of stone, brick, tile, or concrete blocks, usually with the use of mortar or cement as a bonding agent.

1. Terminology

- a. Masonry Units - Brick, stone, tile, or concrete block which are laid in courses with mortar joints.
- b. Brick - Solid, rectangular-shaped units which are created by kiln-baking various clay and shale mixtures; they can vary in colors and hardnesses but are of uniform size. In the U.S., bricks measure 2 1/4" by 3 3/4" by 8."
- c. Tile - Hollow rectangular units made from burning clay and shale. The shape is created by forcing the pliable clay mixture through a molding die. The widths and thickness differ depending on the style of tile; however, the length is always a standard 12."
- d. Stone - There are six kinds of natural stone construction: granite, marble, slate, limestone, sandstone, and bluestone. Stone can be purchased in three finishes: dressed, semi-dressed, and undressed. The shapes and dimensions vary according to the stone and finish used.
- e. Concrete Block - Ready-made, pre-cast units made from portland cement and fine aggregates such as sand, pebbles, crushed rock, or cinders. The concrete mixture is then forced into a mold of the desired shape.
- f. Mortar - A mixture consisting of portland cement, hydrated lime, sand, and water. This is what holds the units together
- g. Laying Block - The process of mixing mortar, applying it to block, and placing the block to create walls.
- h. Courses - the layers of the masonry units
- i. Mortar Bed - A layer of mortar on which the masonry units are laid.

2. Tools

- a. Brick Trowel - used by the mason in laying units and when working with mortar. It is pointed and measures 4 3/4" by 11."
- b. Mortar Board - wooden board used to hold mortar near the work site.
- c. Jointing Tool - used to tool mortar joints; compresses mortar, and makes joint watertight. It comes in different shapes.

- d. Carpenter's Level - a device used to ensure that courses are plumb and level
- e. Builder's Line - used to ensure that courses are straight
- f. Mason's Hammer - a specialized hammer used to cut masonry units to desired sizes
- g. Star Drill - a specialized hand drill used to drive holes in masonry and concrete. The drill point is temper hardened and looks somewhat like a four-point star; the shank is made of high-grade carbon steel. It is operated by striking with a hammer.
- h. Carbide-Tipped Masonry Drill - a specialized power drill used for drilling holes in masonry and concrete. The tip is treated with tungsten-carbide to resist heat and wear.

NOTE: All of the following information refers only to the installation of concrete blocks; however, the installation of brick, tile, and stone is very similar.

B. Types of Blocks

1. Standard Dimensions:

- a. Length - 15 5/8 inches
- b. Height - 7 5/8 inches or 3 5/8 inches
- c. Width - 7 7/8, 3 5/8, 5 5/8, 9 5/8, or 11 5/8 inches
- d. When laid with a 3/8-inch mortar joint, the block's overall dimensions are 8" by 8" by 16" (7 5/8 X 7 5/8 X 15 5/8).

2. Block Style

- a. Hollow or Solid - Hollow spaces are called cores; a solid unit has a core area of 25% or less of the total cross-sectional area.
- b. Heavyweight or Lightweight - Heavyweight units weigh approximately 40-50 lbs. while the lightweight units weigh approximately 25-35 lbs. The difference in weight is due to the different types of aggregates used in manufacture.

3. Block Shapes

- a. Stretcher - This is the most commonly used block for straight wall runs; it has slight extensions called ears on each end which form a core when laid end to end. (2 or 3 core)
- b. Corner - same as a stretcher except that one end is smooth; it is used at the end or corner of a wall.

- c. Half Block - both ends are smooth; it is used for openings and ends of walls.
- d. Sash or Jamb - have special grooves for the installation of windows or doors.
- e. Miscellaneous - solid top, partition, bull nose, half-height, lintel; each has a special application.

C. Job Estimation

1. How many blocks?

- a. To estimate the number of blocks (8 X 8 X 16) needed for a wall, use this formula:

$$1) \text{ Height of Wall} \times 1 \frac{1}{2} = \text{Number of Courses (A)}$$

- a) One foot (12 inches) is $\frac{12}{8}$ or $\frac{3}{2}$ or $1 \frac{1}{2}$ of the height of a block.
- b) The height can then be multiplied by $1 \frac{1}{2}$ to determine the number of courses needed.

$$2) \text{ Length of Wall} \times \frac{3}{4} = \text{Number of Blocks per Course (B)}$$

- a) One foot is $\frac{3}{4}$ the length of one block.
- b) Therefore, the length of the wall in feet can be multiplied by $\frac{3}{4}$ which gives the number of blocks needed for one row.

$$3) A \times B = \text{Total Number of Blocks (for 1 wall)}$$

- b. When planning a project, it is important that the dimensions between corners and all openings utilize full- or half-length block; this will save time and money and improve the overall appearance of the project.

2. How much mortar?

- a. Purchase approximately $2 \frac{1}{2}$ bags of masonry cement and 667 lbs. of mortar sand for each 100 blocks.

ACTIVITY:

1. Have students complete homework assignment which entails writing down all the uses of masonry construction around their home.
2. Take students on a short field trip around the school and have them identify the masonry construction used.
3. Plan out a site where some masonry construction is needed around the department or school.

D. Footing Construction

1. Footing or Footer

- a. This is a continuous slab of concrete which provides a solid, level foundation for block or brick.
 - 1) It should be at least as deep as the wall is wide (i.e., 8" wide wall should rest on a footer that is at least 8" deep).
 - 2) The footer width should be at least twice that of the wall (i.e., an 8" wall should rest on a footer 16" wide).
 - 3) Where temperatures drop below 32 degrees F., footers should be placed below the frost line to prevent damage.
 - a) The frost line is the maximum depth that the soil freezes.
- b. A trench is dug by backhoe or shovel with the width and depth corresponding to the footing size.
- c. Concrete is poured into the trench and leveled to the desired height of the footing.
- d. Use a regular 5:1 concrete mix for the footing.
- e. Make sure to install a horizontal reinforcement bar to strengthen the footing from the weight created by the block wall.
- f. Vertical reinforcement should be used if the wall is to be higher than three feet. It should be placed so it will pass through one core of every two to three blocks; this, however, depends on wall length.

E. Mortar Preparation

1. Ingredients

- a. Masonry cement (mortar mix)

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- 1) When purchased, the correct proportions of lime have already been added to portland cement.
- 2) Sacks come in 1 cubic foot amount with the correct amount of sand to be added printed on the sack.

b. Mortar Sand

- 1) This is special-sized sand for the specific purpose of use in mortar mix.
- 2) Regular sand can be used but it must be screened to remove the larger particles.
- 3) For general work, about three parts of sand are added to one part of mortar mix.

c. Water - Add just enough water to make the mix workable i.e., pliable enough to support the units on a 3/8" mortar joint until it has set.

- 1) If mortar is too stiff (not enough water) it will not bond tightly to the block.
- 2) If it is too thin, it will be squeezed out of the joint by the weight of the block. If this happens, the joint will be less than 3/8."

2. Mixing

a. Small Batches

- 1) Mix the mortar in a mortar pan, wheelbarrow, or a leak proof pan.
- 2) Stir or mix with a mortar hoe or regular garden hoe.
- 3) Mix dry materials to a uniform color before adding water.
- 4) After adding water, mix mortar thoroughly until it is pliable and workable.

b. Large Batches (more than two wheelbarrows full)

- 1) Use a motor or engine-driven mixer to ensure more thorough and efficient mixing.
- 2) Some of the water should be added first, then the dry materials, and, finally, the amount of water needed to obtain the right consistency.

F. Laying Block

1. Methods

- a. Use a corner pole to ensure that the block are laid straight and plumb at each end of the wall.
 - 1) A corner pole is a straight piece of wood or metal held plumb by diagonal supports.
 - a) It is used to support the builder's line to which the wall is built.
 - b) The pole also has lines marked on it which represent the correct height of each course.
- b. A carpenter's level can also be used as a guide to lay block corners.
 - 1) The level can be used to both level and plumb the block.
 - 2) The corners are built first and then the areas between them are filled with courses of stretcher block. A line is used to keep the courses straight.

NOTE: The following procedure uses the corner pole method where the builder's line is repositioned after each course is laid. The height of each course is constantly checked to be a full 8 inches by using the marks on the corner poles.)

2. Procedures

- a. Start from a corner with a corner-shaped block.
- b. Spread a full layer of mortar (mortar bed) on the footing.
 - 1) The webs of the block as well as the face shells or outer edges are bedded in mortar.
 - 2) Place about 1/2" of mortar on the footing so when the block is pushed into it firmly the bed measures 3/8 of an inch.
- c. Lay the first corner block carefully.
 - 1) Position it so the outside corner is exactly where the outside corner of the wall should be.
 - 2) Place it so the thinner part of the web is down.
 - 3) Level the block, first crosswise and then lengthwise.

- 4) Use the trowel handle to tap the block into position and level it.

d. Lay the second (stretcher) block.

- 1) Stand a block on end and butter (apply mortar to) the two projecting ends (ears) with a downward wiping or swiping stroke with the trowel.
- 2) Put the block firmly in place and level it.

e. Lay several stretcher block by working away from the end or corner.

- 1) Check the first course for:

- a) Levelness crosswise and lengthwise
- b) Outside edges for plumb
- c) That the block forms an even straight line.

- 2) Use the end of the trowel handle until each block is plumb, level, and the course is straight.

f. In preparation for the second course, apply a mortar bed to the top of the first course.

- 1) Above the first course, it is necessary to apply mortar only to the face shells or outer edges.
- 2) Some local codes require full bedding for all courses so check local codes before starting a job.

g. If extra strength is needed, install reinforcement wire in the mortar bed.

h. Trim off excess mortar with the edge of the trowel as the block laying progresses.

i. To reposition the builder's line after each course is laid the line is positioned to be level along the top of the block.

j. Check the height to be sure each course is an additional 8 inches high.

k. If a block must be cut to a certain size:

- 1) Use a mason's hammer and make multiple strikes along the line to be cut.
- 2) Then make one sharp rap on the edge of the web.

- 3) Try to keep cutting of blocks to a minimum since it hurts the appearance of the project and drastically increases the labor required to finish a job.

l. As work progresses and the mortar begins to dry and stiffen, the joints can be tooled.

- 1) Joints should be compacted and finished.

- a) This produces a tight, water-resistant joint.
- b) It also emphasizes the joint lines and gives the job a neat appearance.

- 2) Tools are available to create a variety of joints such as concave, V-shaped, or raked.

- a) A flush joint can be obtained by rubbing it with a broken piece of block. If the wall is to be plastered or stuccoed, leave the joint flush.

m. Pouring the grout for reinforcement

- 1) All block cores holding vertical steel reinforcement rods must be filled solid with grout.

- a) Grout mix contains 5 parts sand to 1 part cement; it is mixed very wet.
- b) If desired, gravel can also be used.

- 2) A tamping rod should be used to ensure that the grout goes down to the footing.

- 3) A solid, reinforced concrete pier will be formed in the wall.

n. For a wall supporting a roof frame where wooden plates need to be fastened:

- 1) Embed 1/2-inch anchor bolts 18 inches long in grout in the cores of the top two courses.
- 2) Space the bolts no more than 4 feet apart.
- 3) Metal lath (wire mesh) is placed two courses down to support the bolts.

o. The final step in building with block is the finishing of the top.

1) The top of the wall may be finished with any of the following methods:

- a) A solid masonry course using solid-top block or solid 2-inch-thick cap block. This course must be laid with as much care as the first course.
- b) A course of decorative, design blocks.
- c) A crown of regular mortar mix round and trowel smooth supported by metal lath in the course below.
- d) A flush top of block with cores filled with mortar mix supported by metal lath in the course below.

ACTIVITY:

1. Have students complete the project planned in the beginning of this lesson. (If you are not an expert mason do not worry, contact a local concrete or mason contractor for some advice. Don't be surprised if they are willing to come out and donate their time.)
2. Take students to a job site where masonry construction is being done.

SAFETY IN MASONRY WORK

Observe the following general safety practices in doing all masonry work.

1. Wear proper safety equipment. When doing masonry work, wear safety glasses, safety shoes, and a hard hat.
2. Wear gloves. Masonry units and concrete are abrasive. Wear gloves to protect your hands when you handle these products.
3. Wear a respirator. When working in masonry dust, wear a filter-type respirator.
4. Check equipment before you use it. Be sure that hoists, scaffolds, and ladders are properly assembled and secured before you use them.
5. Stack masonry materials carefully. Masonry materials such as concrete blocks and dry cement are bulky and heavy; if improperly stacked, they can easily fall, causing injury.
6. Operate concrete and mortar mixers cautiously. Be certain all guards are in place and if a mixer is electric, that it is properly grounded.
7. Use chemicals with extreme care. Many chemicals needed for masonry work, such as muriatic acid and trisodium phosphate, are harmful to the skin and clothing and must be used carefully. When using masonry chemicals, wear rubber gloves to avoid damaging your skin.
8. Check all concrete forms. Poorly constructed forms endanger lives. Check them for strength and safety before you use them.

9. Place tools in a convenient location. Place tools for working convenience but never where you or others would be endangered.
10. Know proper lifting procedures to avoid back injuries.

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Name _____

Date _____

Score _____

CONCRETE AND MASONRY, UNIT EXAM

Circle the best answer.

1. Concrete is a mixture of sand, gravel, water, and _____?
 - a. clay cement
 - b. finishing cement
 - c. finishing lime
 - d. portland cement

2. The strength and durability of concrete are dependent on the:
 - a. purity of water
 - b. ratio of stone aggregates by size
 - c. type of cement
 - d. all of the above

3. To prevent forms from sticking to the concrete, they are treated with:
 - a. fat
 - b. paint
 - c. form oil
 - d. wax

4. Concrete is reinforced with:
 - a. air bubbles
 - b. steel bars
 - c. wood fibers
 - d. aluminum wire

5. Concrete is cured by:
 - a. covering with plastic, straw, etc.
 - b. protecting from wind
 - c. sprinkling with water
 - d. all of these

6. A standard sack of portland cement contains:
- a. 94 pounds
 - b. 90 pounds
 - c. 1.5 cubic yards
 - d. 1 cubic yard
7. The process of "striking off" the excess concrete to match the top edge with the form is called:
- a. troweling
 - b. brooming
 - c. floating
 - d. screeding
8. After screeding concrete, what tool is used for floating?
- a. Straight Edge
 - b. Broom
 - c. Bull Float
 - d. Finishing Trowel
9. The groover or jointer is used to cut joints in concrete slabs while the edger is used to round off corners.
- a. True
 - b. False
10. When using a mixer, load all the coarse aggregate and all the specified water with the mixer stopped. Then follow the remaining steps as indicated.
- a. True
 - b. False
11. Concrete is finished with a steel trowel:
- a. after the water sheen has disappeared
 - b. after the surface has dried
 - c. immediately after the second floating of the surface
 - d. immediately after the concrete is poured
12. The presence of organic matter and silt in the water or aggregates used in concrete does not reduce the strength or durability of the concrete.
- a. True
 - b. False

13. When working with concrete, which step comes first?

- a. Screeding
- b. Tamping
- c. Floating
- d. Troweling

14. An acceptable range of slump for general purpose concrete used in an agricultural situation is:

- a. 2" to 8"
- b. 6" to 10"
- c. 1" to 3"
- d. 3" to 6"

15. To obtain a non-skid finish that will assure the best traction, use a:

- a. bull float
- b. broom
- c. wood float
- d. steel trowel

16. If the sand to be used in concrete is considered "wet":

- a. more water should be used in the mix.
- b. less water should be used in the mix.
- c. more gravel should be used in the mix.
- d. none of the above.

17. The strength of concrete is determined by the ratio of:

- a. water to sand
- b. cement to gravel
- c. sand to gravel
- d. water to cement

18. The maximum size coarse aggregate to be used in a wall is:

- a. 1/4 the wall thickness
- b. 1/5 the wall thickness
- c. 1/3 the wall thickness
- d. 1/2 the wall thickness

19. In a 1 : 2 1/4 : 2 3/4 mix ratio, the one (1) refers to the proportion of _____.

- a. water
- b. coarse aggregate
- c. fine aggregate
- d. cement

20. In the cement ratio 1:2:3, the amount of fine aggregate would be:

- a. three times the amount of cement
- b. two cubic feet
- c. two times the amount of cement
- d. three cubic feet

21. Which of the following tools is most appropriate for squaring forms for a large concrete slab?

- a. Carpenter's square
- b. Try square
- c. Surveyor's level
- d. Tape measure to lay out a right triangle

22. One cubic yard of concrete is equal to:

- a. 3 cubic feet
- b. 9 cubic feet
- c. 27 cubic feet
- d. 144 cubic feet

23. The actual size of a standard concrete masonry block is:

- a. 7 3/8 X 7 3/8 X 15 3/8
- b. 7 5/8 X 7 5/8 X 15 5/8
- c. 8 X 8 X 16
- d. 8 3/8 X 8 3/8 X 16 3/8

24. A six gallon paste mix should contain 6 gallons of water per sack (cubic foot) of:

- a. concrete
- b. cement
- c. sackrete
- d. mortar mix

25. _____ is a mixture of sand, portland cement, water, and finishing lime.

- a. Sackrete
- b. Concrete
- c. Mortar
- d. Grout

26. Drinking water generally is suitable for mixing concrete.

- a. True
- b. False

27. Concrete allowed to cure for one month will be about twice as strong as concrete which is allowed to dry immediately.

- a. True
- b. False

28. How many standard size blocks will it take to lay a 16 foot wall that is 2 feet high?

- a. 30
- b. 36
- c. 40
- d. 42

29. How many cubic yards of concrete must be ordered to pour a 4 inch slab for a 24 foot by 27 foot shop floor?

- a. 8
- b. 27
- c. 216
- d. 2592

(NOTE: To complete the rest of the test handouts covered in the previous lessons must be given to the students.)

A concrete driveway is to be poured on a level surface. The concrete is to be ordered from a "batch" (Ready Mix) plant. The dimensions of the slab are: 6 inches thick, 16 feet wide, 54 feet long. Allow 5% overage for uneven surface of the ground.

SHOW ALL YOUR WORK!

30. How many cubic feet of concrete are needed to complete the job?

_____ cubic feet

31. How many cubic yards should be ordered?
(Round off answer to nearest 1/4 or 1/2 of cubic yard.)

_____ cubic yards

32. Specify the maximum size of aggregate.

_____ inches

33. Specify the proportions desired for a one sack batch.

_____ : _____ : _____
CEMENT SAND GRAVEL

34. Specify the amount of cement needed for 1 cubic yard of concrete.

_____ sacks

35. Specify the water - cement ratio used for the job at hand.

_____ gallon paste

36. Specify the amount of slump.

_____ inches

37. Calculate the Ready Mix cost. (\$55.00/Cubic Yard)

\$ _____

38. Now that you are experienced masons, you can go out and pour some concrete on your own! Right?

- a. True
- b. False

130M-45

Unit Exam

Worksheet #1

Worksheet #2

1. D
2. D
3. C
4. B
5. D
6. A
7. D
8. C
9. A
5.1
10. B
11. C
5.8
12. B
13. B
14. D
15. B
16. B
17. D
18. B
19. D
20. C
21. D
22. C
23. B
24. B
25. C
26. A
27. A
28. B
29. C
30. $454 (453.6) = 16' \rightarrow 54' \rightarrow 6''$
31. $17\text{cu.yd. } (16.8\text{cu.yd.}) = 454/27$
32. 2"
33. 1:2:3
34. $4.5 = 27/6$
35. $6 \frac{1}{2}$
36. 3"-4"
37. $\$935 = 17\text{cu.yd.} \rightarrow \55
38. ?

1. 1.7" ($1 \frac{1}{2} - 1 \frac{3}{4}$)
2. 1:2:3
3. 4.5 or $4 \frac{1}{2}$
4. 9 sand $13 \frac{1}{2}$ gravel
5. 45sks 90 cu/ft sand
135cu/ft gravel

1. 10 sacks
2. $\frac{1}{3}\text{yd}$ (.40 rounded up)
3. A. 3 sacks ($2 \frac{1}{3}$ sacks rounded up)
B. 5.1cu/ft
 $\frac{1}{2} \text{ cu/yd} = 13.5 \text{ cu/ft}$
 $1 + 2 + 2.25 = 5.25$
 $13.5 / 5.25 = 2.57$
 $2.57 \rightarrow 2 = 5.14 \text{ or}$
- C. 5.8cu/ft
 $2.57 \rightarrow 2.25 = 5.78 \text{ or}$

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Burke, Stanley R., & Wakeman, T. J. (1990). MODERN AGRICULTURAL MECHANICS (2nd ed.). Danville, IL: Interstate Publishers.

Cooper, Elmer L. (1987). AGRICULTURAL MECHANICS: FUNDAMENTALS AND APPLICATIONS. Albany, NY: Delmar Publishers.

Editors of Reader's Digest. (1973). COMPLETE DO-IT-YOURSELF MANUAL (7th ed.). Pleasantville, NY: Reader's Digest Association.

Wagner, Willis H. (1979). MODERN CARPENTRY: Building Construction Details in Easy-to-Understand Form (4th ed.). So. Holland, IL: Goodheart-Willcox.

U.S. Dept. of the Army. CONCRETE, MASONRY, AND BRICKWORK: A PRACTICAL HANDBOOK FOR THE HOMEOWNER AND SMALL BUILDER. New York: Dover Publications.

Resources:

Ahrens, Donald L. (1988). CONCRETE AND CONCRETE MASONRY. Available from: Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112
Phone: (612) 633-3170 (Catalog available)

Midwest Plan Service. (1980). STRUCTURES AND ENVIRONMENT HANDBOOK. (10th ed.). Available from: Midwest Plan Service, 122 Davidson Hall, Iowa State University, Ames, Iowa 50011

Special Materials and Equipment:

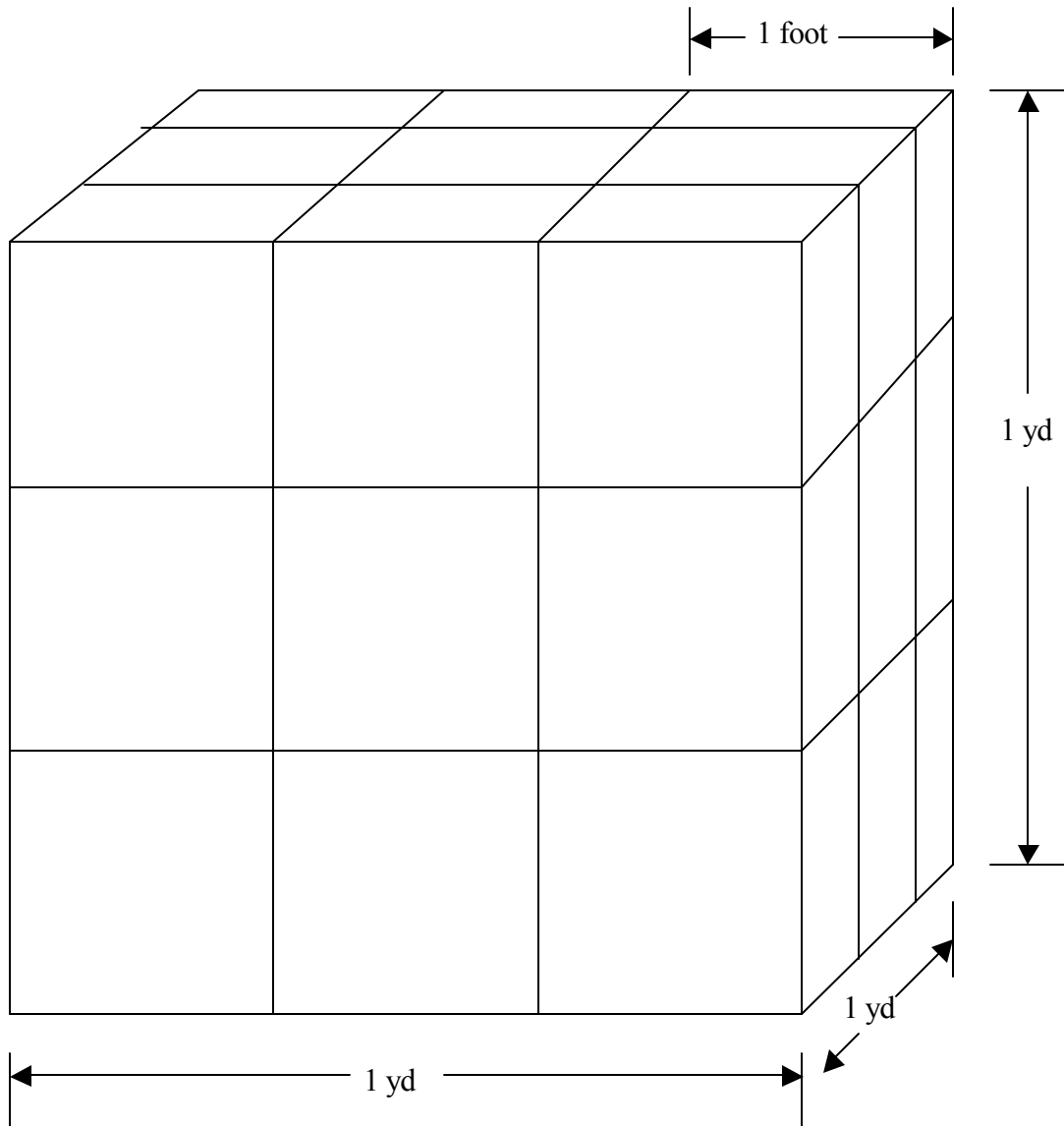
Calculators, volume container examples

Form and batter boards, builder's twine, stakes, wire mesh, rebars, wire, level, nails, hammers, rakes, 100 ft. tape, shovels, Brick trowel, edger, groover, wood or magnesium float, screed board, finishing trowel, wheelbarrow, bull float, tamper, push broom, slump cone w/rod, water hose, shovels, also possibly concrete ingredients, portable mixer, power trowel, Brick trowel, wheelbarrow, water hose, shovels, level, builder's line, jointer, mortar board, mortar ingredients, portable mixer: also possibly rebars, anchor bolts, sill lumber, and assorted examples of masonry

MIXTURE RATIOS

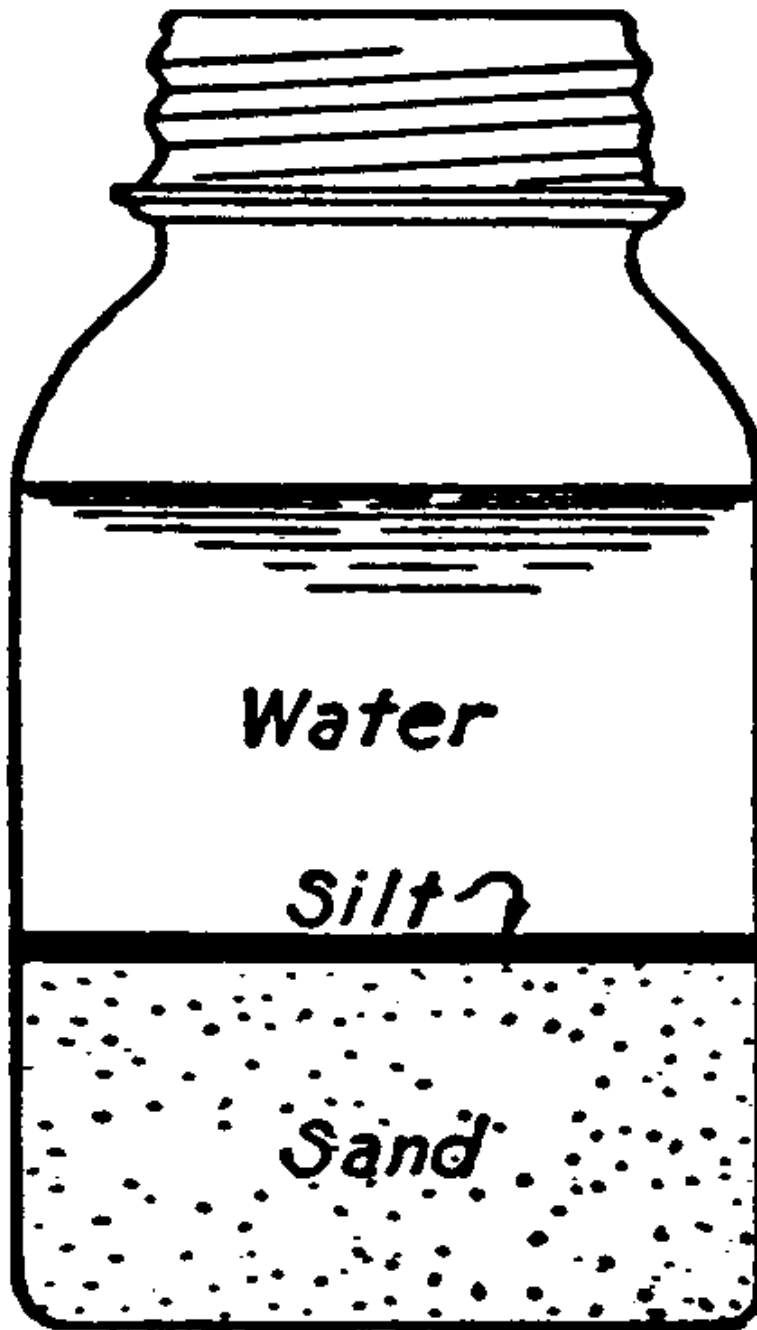
Kind of work	Mixture Ratios			Required water per sack of cement when sand is---		
	Cement, Sacks	Sand, ft ³	Gravel, ft ³	Wet Gal.	Moist Gal	Dry Gal
Very thin work, 2 to 4 inches thick (milk cooling tanks)	1	2	2	3 ½	3 ¾	4 ½
Abrasion resistance, 4 to 8 inches thick (stock tanks, driveways)	1	2	3	3 ¾	4 ½	5 ½
General reinforced, 8 to 12 inches thick (basement walls, steps)	1	2 ½	3 ½	4 ½	5	6 ½
Mass concrete, (footings, foundation walls)	1	3	5	5	6	7

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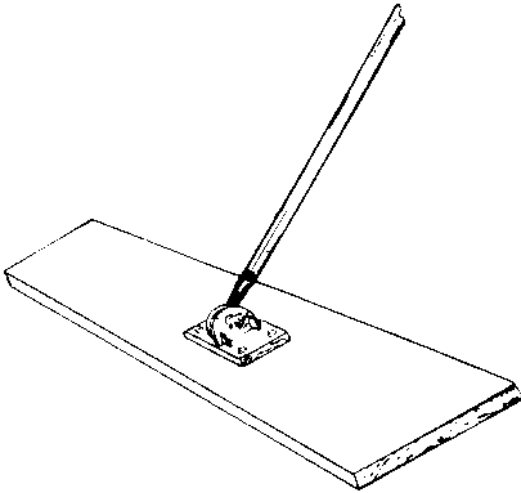
1 cubic yard = 27 cubic feet

130M-49

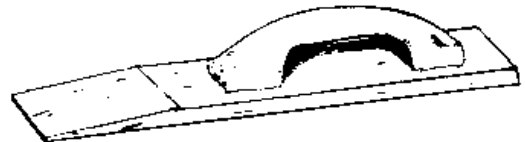


Silt Test

TOOLS USED IN CONCRETE WORK



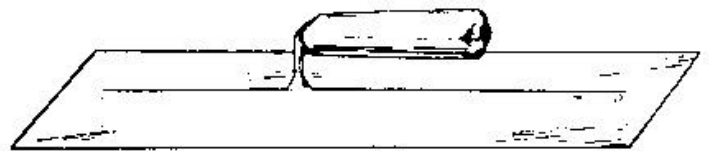
BULLFLOAT



WOOD FLOAT

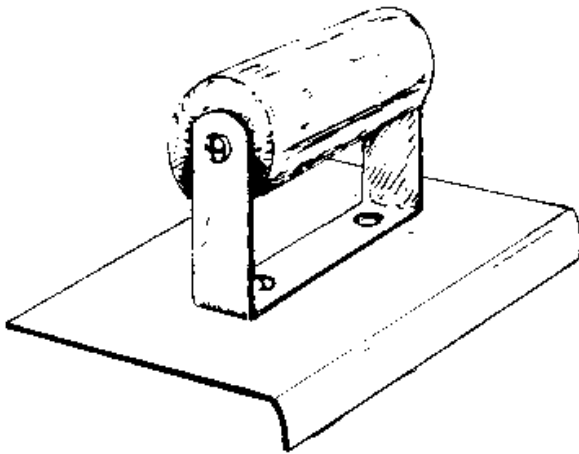


MAGNESIUM FLOAT

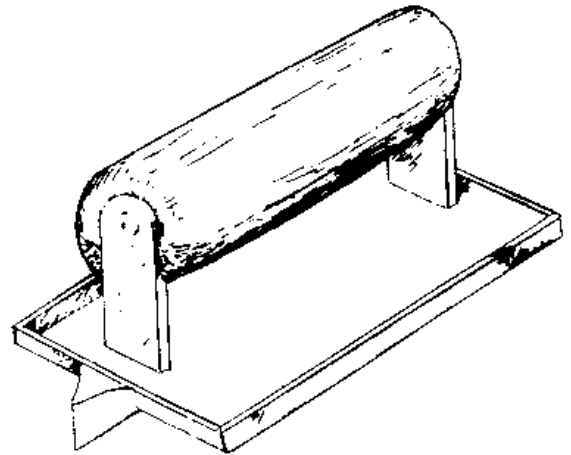


FINISHING TROWEL

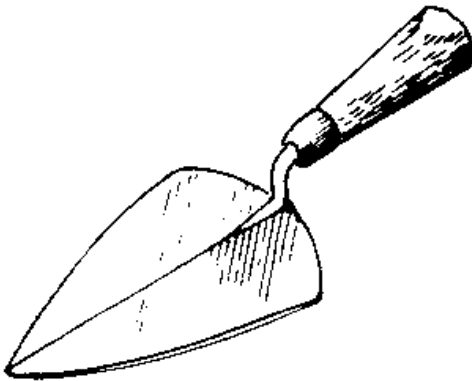
TOOLS USED IN CONCRETE WORK



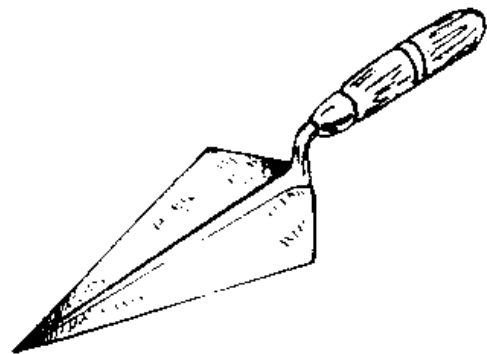
EDGER



JOINTER OR GROOVER



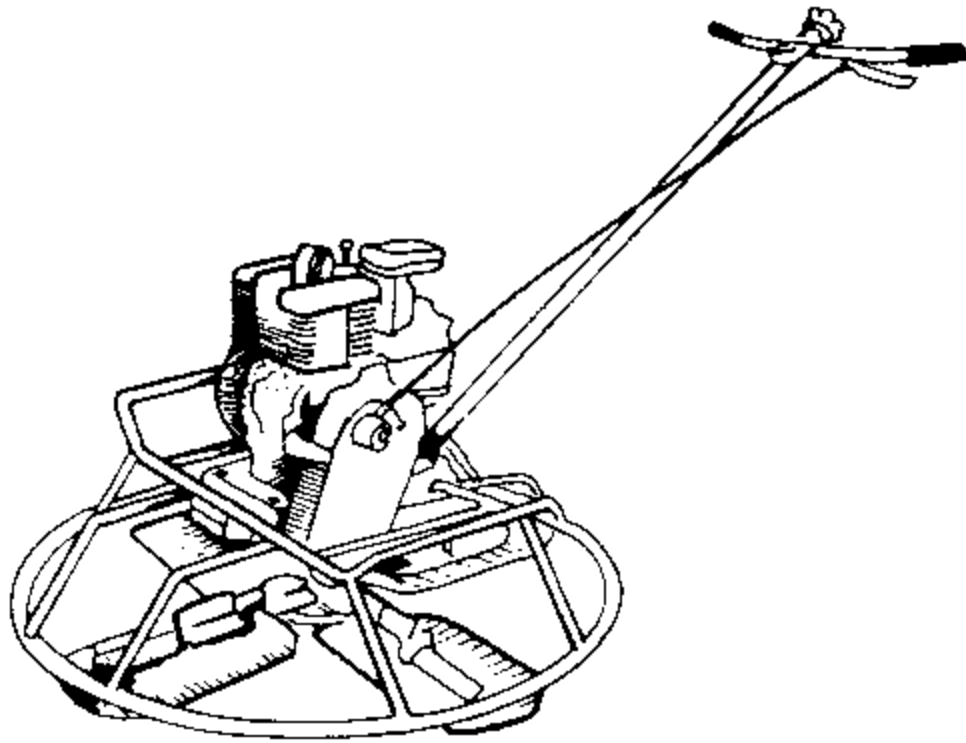
BRICK TROWEL



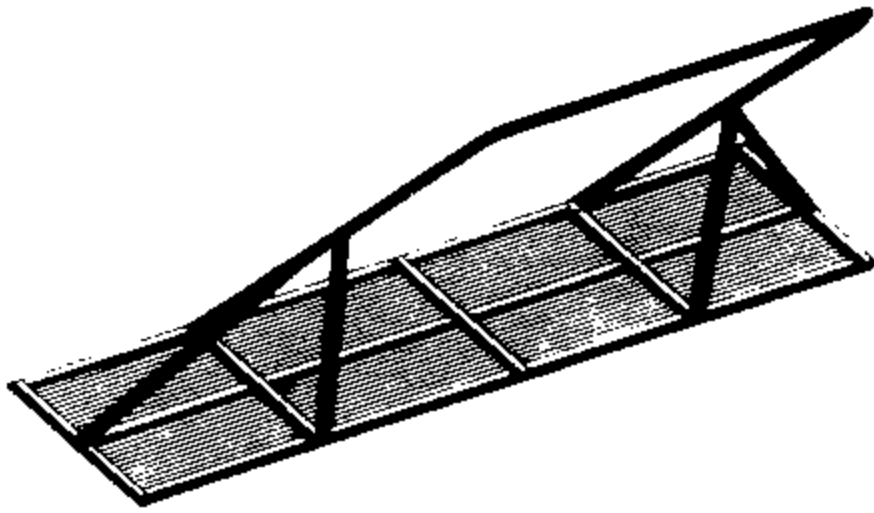
POINTING TROWEL

130M-52

TOOLS USED IN CONCRETE WORK



POWER TROWEL



HAND TAMP